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10/538,217	06/09/2005	Erwin A Hijzen	NL02 1418	9412

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EXAMINER	
DUONG, KHANH B	

ART UNIT	PAPER NUMBER
2822	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

ip.department.us@nxp.com

Office Action Summary	Application No.	Applicant(s)	
	10/538,217	HIJZEN	
	Examiner	Art Unit	
	Khanh B. Duong	2822	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 April 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-16* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *11-16* is/are allowed.

6)☒ Claim(s) *1,2,4-6 and 8-10* is/are rejected.

7)☒ Claim(s) *3 and 7* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *30 April 2007* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

This office action is in response to the amendment filed on April 30, 2007.

Accordingly, claims 1, 3 and 9 were amended, and new claims 11-16 were added.

Currently, claims 1-16 are pending.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 9 and 10 are rejected under 35 U.S.C. 102(b) as being anticipated by Murphy (U.S. Patent No. 6,444,528).

Re claim 9, Murphy, submitted by Applicant in IDS, discloses in at least FIG. 2 a trench MOSFET comprising: a drain region 16 of first conductivity type; a body region 22 over the drain region 16; a trench 10 extending from a first major surface through the body region 22; source regions 18 of the first conductivity type laterally adjacent to the trench 10 at the first major surface; thermal gate oxide 21 on the side walls 11 of the trench 10; a gate electrode 15 in the trench 10 insulated from the body region 22 by the gate oxide 21; characterized by a thick oxide plug 27 at the base of the trench 10 extending into the drain region 16 [see col. 3, lines 29-58].

Claim 9 recites the following product-by-process limitations: "a thick oxide plug formed of oxidized porous silicon". However, these limitations have not been given patentable weight

because product-by-process claims are not limited to the manipulations of the recited steps, only the structure implied by the steps. "[E]ven though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself. The patentability of a product does not depend on its method of production. If the product in the product-by-process claim is the same as or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process." In re Thorpe, 777 F.2d 695, 698, 227 USPQ 964, 966 (Fed. Cir. 1985).

Re claim 10, Murphy discloses the body region 22 is of second conductivity type (p-type) opposite to the first conductivity type (n-type).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various

claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 2, 4-6 and 8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Murphy in view of Lynch et al. (U.S. Patent No. 4,643,804).

Murphy discloses in FIGs. 2 and 8-13 a method of manufacturing a trench gate semiconductor device comprising the steps of: providing a silicon device body having a first major surface, the silicon device body having a drain region 16 of a first conductivity type and a body region 22 over the drain region 16 (FIG. 2); forming a trench 34 extending downwards into the silicon device body from the first major surface, the trench 34 having sidewalls 35 and a base 36 (FIG. 8); etching silicon at the base 36 of the trench 34 to expose silicon at the base 36 of the trench 34 (FIG. 10); thermally oxidizing the device to oxidize the exposed silicon at the base 36 of the trench 34 to form a plug 56 at the base 36 of the trench 34; and depositing conductive material within the trench 10 to form a gate 15 (FIG. 2).

Re claim 1, Murphy does not disclose etching the silicon at the base of the trench to form porous silicon at the base of the trench, and thermally oxidizing the device to oxidize the porous silicon at the bottom of the trench to form a plug at the base of the trench.

Lynch et al. ("Lynch") shows in FIGs. 3-5 etching the silicon at the base of a trench 10 to form porous silicon 32 at the base of the trench 10, and thermally oxidizing the device to oxidize the porous silicon 32 at the bottom of the trench 10 to form a plug 34 at the base of the trench 10

[see col. 3, line 39 to col. 4, line 46]. The purpose for such teaching would have been to minimize the stress level in the plug region and improve the electrical characteristics of trenches that include bottoms having surface roughness and/or sharp or irregular corners [see Abstract; and col. 4, lines 45-46].

Since Murphy and Lynch are from the same field of endeavor, the purpose disclosed by Lynch would have been recognized in the pertinent prior art of Murphy.

Therefore, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Murphy as suggested by Lynch because of the desirability to minimize the stress level in the plug region and improve the electrical characteristics of trenches that include bottoms having surface roughness and/or sharp or irregular corners.

Re claim 2, Lynch expressly shows in FIGs. 2-4 after the step of etching the trench 10, the step of lining the side walls of the trench 10 with dielectric liner 30 for preventing the side walls becoming porous during the step of forming porous silicon 32 at the bottom of the trench 10.

Re claims 4 and 5, Murphy expressly discloses in FIG. 8 wherein the step of forming the trench 34 includes providing a mask (oxide 38 & nitride 40) on the first major surface defining an opening and etching the trench 34 extending downwards from the first major surface through the opening.

Re claim 6, Lynch shows in FIG. 4 wherein the step of etching the silicon at the bottom of the trench 10 to form porous silicon 32 includes dry-etching (dry anodization) or wet-etching

(wet anodization) the bottom of the trench 10 through the same mask 26 used to define the trench 10.

Re claim 8, Murphy expressly discloses in FIG. 2 forming a source implant 18 of first conductivity type at the first major surface adjacent to the trench 10 and forming source, gate and drain electrodes attached to the source implant 18, the gate 15 and the drain region 16 at the bottom of the trench 10 respectively to complete the trench gate semiconductor device.

Allowable Subject Matter

Claims 3 and 7 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 11-16 are allowed.

The following is a statement of reasons for the indication of allowable subject matter: none of the prior art of record, taken alone or in combination, fairly shows or suggests all the limitations as claimed.

Re claim 11, none of the prior art of record discloses the following limitations in combination with the rest of the limitations in the claim: thermally oxidizing the device to oxidize the porous silicon at the base of the trench to form a plug at the base of the trench, wherein thermally oxidizing the device forms sidewall oxide on the sidewalls of the trench.

Response to Arguments

Applicant's arguments filed April 30, 2007 have been fully considered but they are not persuasive.

Applicant argues that the claimed limitation "a thick oxide plug formed of oxidized porous silicon" is not a product-by-process limitation. In response, the Examiner respectfully disagrees because the limitation "oxidized porous silicon" is translated to a specific process of oxidizing porous silicon to form an oxide plug. In addition, Applicant states that the claimed plug is made of silicon that is both oxidized and porous. In response, the Examiner disagrees because the specification does not disclose whether the silicon oxide plug itself is porous after the thermal oxidation of the porous silicon [see specification, paragraph 0030].

Applicant further argues that the Office Action fails to establish that Murphy is susceptible to the problems associated with trenches that include bottoms having surface roughness and/or sharp or irregular corners. In response, the Examiner respectfully disagrees because the bottom 36 of Murphy's trench 34, as shown in FIG. 3, appears to have surface roughness and/or sharp or irregular corners due to damage from the silicon etch process. Thus, one of ordinary skill in the art would have been motivated to modify the method disclosed by Murphy as suggested by Lynch because of the desirability to minimize the stress level in the plug region and improve the electrical characteristics of trenches that include bottoms having surface roughness and/or sharp or irregular corners.

In response to applicant's arguments against the references individually, one cannot show nonobviousness by attacking references individually where the rejections are based on

combinations of references. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Khanh B. Duong whose telephone number is (571) 272-1836. The examiner can normally be reached on Monday-Friday from 8:00-4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Zandra Smith, can be reached on (571) 272-2429. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

KBD

Zandra V. Smith
Zandra V. Smith
Supervisory Patent Examiner
9 July 2007